

**University of Saskatchewan**  
**EP 155 – Electric and Magnetic Circuits**  
**Midterm Examination #2**

March 20, 2002

**Time :** 7:00-8:30 p.m.

**Student's Name : (Print)** \_\_\_\_\_

**Student's Number:** \_\_\_\_\_

**Section (circle):**      **Section 2** (1:00-2:30 pm)

**Section 4** (2:30-4:00 pm)

**Note :** Please report the final answers in the boxes provided

Please show your work to convince the markers that you understand the material

The value for each partial question is indicated in parentheses

Marks for the exam (do not write in this space):

Q1:	Q4:
Q2:	Q5:
Q3:	Total:

**Problem 1.** A map of equipotential contours is shown the Figure 1 below. The contour lines are 1 volt apart. The electric potential at point A w.r.t. point B is positive (i.e.  $V_{AB}$  is positive). The map is not drawn to scale, so certain distances are marked on the map. Some of these distances are required to answer some of the questions below. The values of the marked distances are:

$$\Delta \ell_B = 1.8\text{ cm} \quad \Delta \ell_{Bx} = 2.1\text{ cm} \quad \Delta \ell_{By} = 4.6\text{ cm}$$

$$\Delta \ell_{AD} = 13.0\text{ cm} \quad \Delta \ell_{Ex} = 1.3\text{ cm} \quad \Delta \ell_{Ey} = 8.4\text{ cm}$$

- What is  $V_{CA}$ ? (1 mark)
- A positively charged particle is placed at point B. Show the direction of the force experienced by the charge. (1 mark)
- If the force on the charged particle placed at point B is 100 N, approximately what is the net charge of the particle? (2 marks)
- A charge of  $+7\text{mC}$  is moved from point D to point A. How much work is done by the mover? (2 marks)
- Approximately what is the strength of the electric field at point E (i.e. force per coulomb of charge)? (1 mark)

a) $V_{CA} =$	d) Work =
b) Show on Figure 1 c) Charge =	e) $E =$

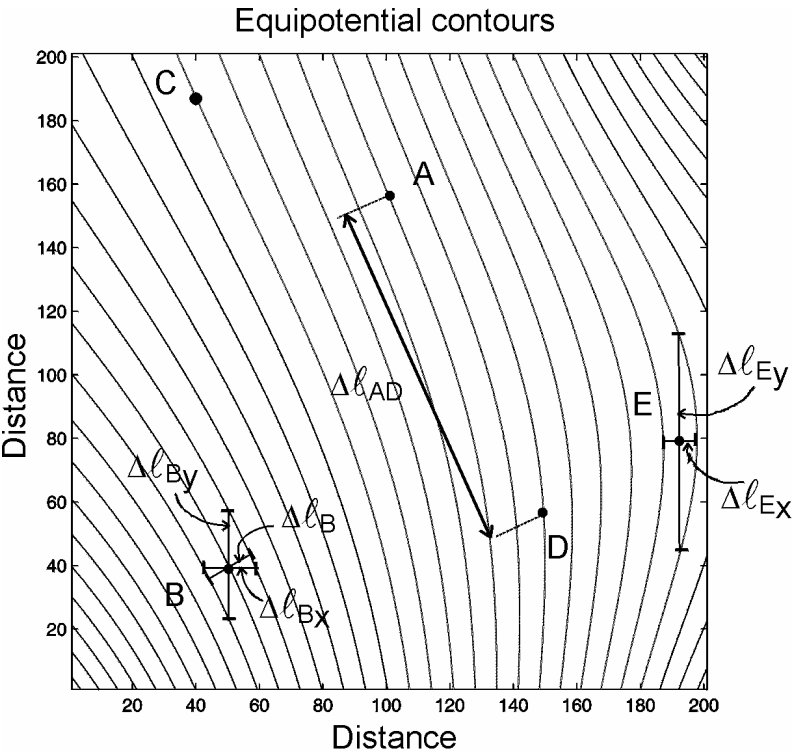


Figure 1.

**Problem 2.** For the circuit shown in Figure 2:

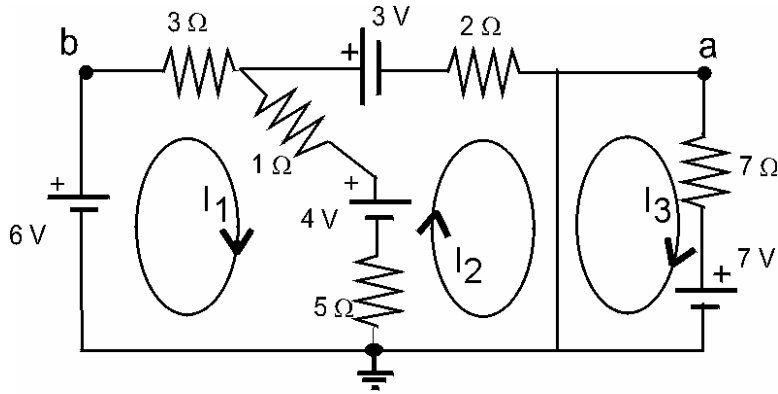


Figure 2.

- a) Write the loop equations in matrix form (4 marks)

$$\begin{pmatrix} & & \\ & & \\ & & \end{pmatrix} \begin{pmatrix} I_1 \\ I_2 \\ I_3 \end{pmatrix} = \begin{pmatrix} \\ \\ \end{pmatrix}$$

- b) Find the magnitude of the current through the 7-Ω resistor. Notice that this can be done without solving the set of equations by determinants. (2 marks)
- c) Is the direction of the current through the 7-Ω resistor up or down? (2 marks)

$ I_{7\Omega}  =$	Direction of $I_{7\Omega}$
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**Problem 3.**

- Write the nodal equations for the circuit shown in Figure 3. Use the matrix template given below. (2 marks)
- Solve for the voltages  $V_1$  and  $V_2$ . (2 marks)
- Find the magnitude and direction (sign) of the current through the 3- $\Omega$  resistor. (2 marks)
- Find the magnitude and direction (sign) of the current through the 6- $\Omega$  resistor. (2 marks)

$V_1 =$	$I_{3\Omega} =$	Sign of $I_{3\Omega}$
$V_2 =$	$I_{6\Omega} =$	Sign of $I_{6\Omega}$

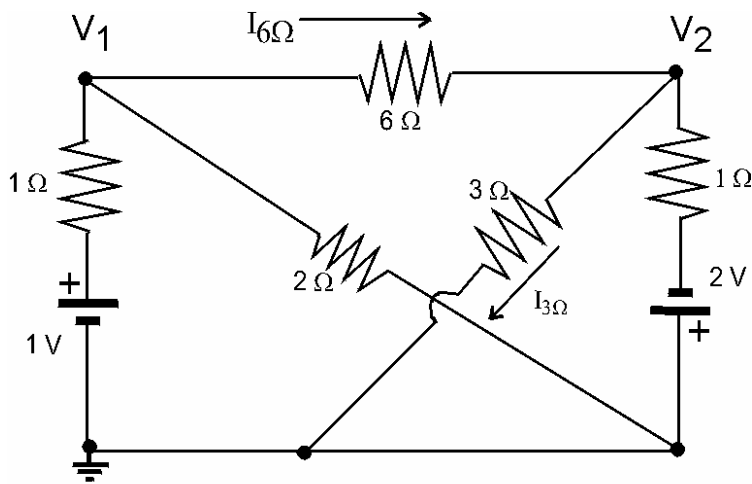


Figure 3.

$$\begin{pmatrix} \phantom{0} \\ \phantom{0} \\ \phantom{0} \end{pmatrix} \begin{pmatrix} V_1 \\ V_2 \end{pmatrix} = \begin{pmatrix} \phantom{0} \\ \phantom{0} \\ \phantom{0} \end{pmatrix}$$

**Problem 4.** Using superposition (Figure 4), find

- the current through the  $2\text{-}\Omega$  resistor due to the voltage source (2 marks)
- the current through the  $2\text{-}\Omega$  resistor due to the current source (2 marks)
- the power delivered to the  $2\text{-}\Omega$  resistor (4 marks)

$I_{2\Omega}(\text{volt.source})=$	$I_{2\Omega}(\text{curr.source})=$	$P_{2\Omega}=$
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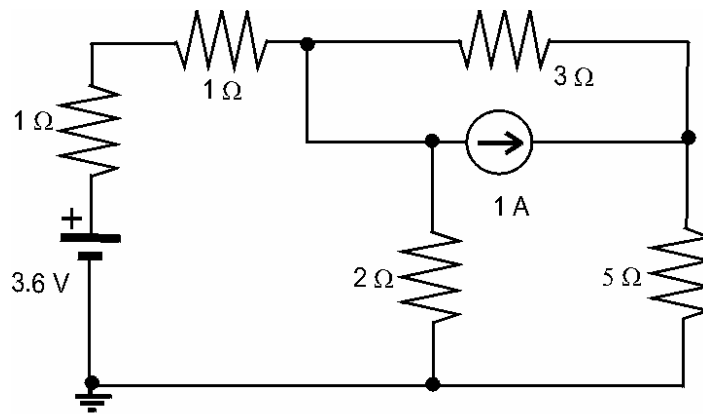


Figure 4.

**Problem 5.** For the circuit depicted in Figure 5:

- Find the Thevenin equivalent resistance between points **a** and **b** (with the switch open) (2 marks)
- Determine the Thevenin's voltage of point **b** with respect to point **a** (with the switch open) (2 marks)
- Find the value of resistance **R** so that, when the switch is closed, maximum power is delivered to **R** (2 marks)
- What is the maximum power that can be delivered to **R**? (2 marks)

$R_{Th} =$	$R =$
$E_{Th} =$	$P_{max} =$

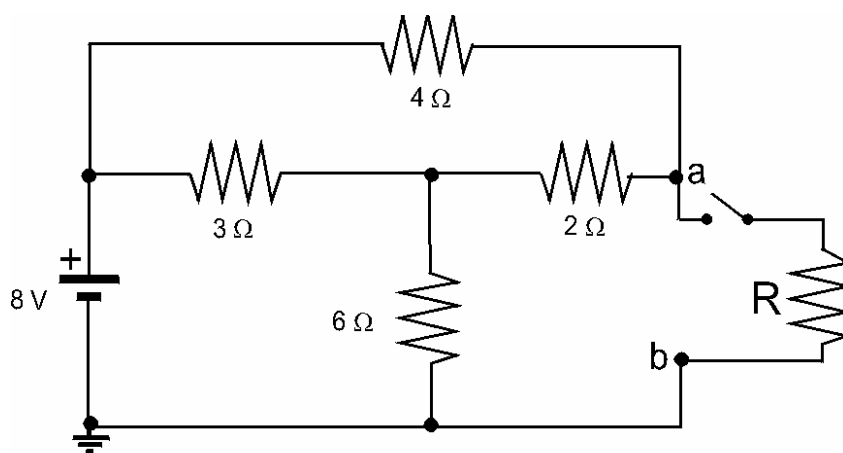


Figure 5.